

## 1.25Gbps Upstream/1.25Gbps Downstream Intelligent GE-PON ONU Transceiver



### FEATURES

- RoHS compliant
- Digital Diagnostic SFF-8472 MSA compliant
- Support extended operating Case temperature from -20°C to +85°C
- IEEE802.3ah Gigabit Ethernet compliant
- SFF package with SC Receptacle
- 1310nm Burst Mode 1.25Gbps transmitter, and 1490nm Continuous Mode 1.25Gbps receiver
- Integrated with WDM filter to cut 1550nm and 1650nm optical signal off
- Single +3.3V power supply with LVPECL electrical signal interface, LVTTTL Bias Control input and Rx Signal Detect output
- Laser Class 1 Product which comply with the requirements of IEC 60825-1 and IEC 60825-2

### Description

DELTA's GE-PON ONU transceiver **OPEP-33-A4Q1RI** is designed for Gigabit Ethernet Passive Optical Network transmission.

The module is contained in a SFF package with standard SC receptacle connector.

The module consists 1310nm FP laser, InGaAs PIN, Preamplifier and WDM filter in a high-integrated optical sub-assembly, and it receives up to 1.25Gbps of continuous data at 1490nm, and transmits 1.25Gbps of burst-mode data at 1310nm.

### Application

- IEEE 802.3ah 1000BASE-PX10-U
- GE-PON ONU
- Burst Mode Application
- FTTx WDM Broadband Access
- OPEP-33-A4Q1RI data link up to 10km in 9/125um single mode fiber.

### 1. Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Storage Temperature	T <sub>s</sub>	-40		85	°C	
Storage Ambient Humidity	HA	5		95	%	
Power Supply Voltage	V <sub>CC</sub>	-0.3		4	V	
Signal Input Voltage		-0.3		V <sub>cc</sub> +0.3	V	
Receiver Damage Threshold		+2			dBm	
Lead Soldering Temperature	T <sub>SOLD</sub>			260	°C	
Lead Soldering Time	t <sub>SOLD</sub>			10	sec	

### 2. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Operating Case Temperature	T <sub>C</sub>	-20		+85	°C	Note (1)
Ambient Humidity	HA	5		85	%	Non-condensing
Power Supply Voltage	V <sub>CC</sub>	3.13	3.3	3.47	V	
Power Supply Current	I <sub>CC</sub>			300	mA	
Power Supply Noise Rejection				100	mVp-p	100Hz to 1MHz
Data Rate		1.25 -100ppm	1.25	1.25 +100ppm	Gbps	
Transmission Distance				10	km	

Note (1). Measured on top side of case front center

### 3. Specification of Transmitter

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Average Launched Power (B.O.L)	P <sub>O</sub>	-0.5		+4	dBm	Note (1)
Average Launched Power (E.O.L)	P <sub>O</sub>	-1		+4.5	dBm	Note (1)
Launched power (Peak.)	P <sub>P</sub>			+7.5	dBm	
Extinction Ratio	ER	9			dB	
Center Wavelength	λ <sub>c</sub>	1260	1310	1360	nm	FP Laser
Spectrum Width (RMS)	σ	Compliant with IEEE 802.3ah			nm	Note (4)
Transmitter OFF Output Power	P <sub>Off</sub>			-45	dBm	
Laser Burst On Time	T <sub>on</sub>			32		
Laser Burst Off Time	T <sub>off</sub>			32		
Optical Rise/Fall Time	t <sub>r</sub> /t <sub>f</sub>			260	ps	Note (2)
Total Jitter	t <sub>j</sub>			128	ps	Note (3)
Optical Return Loss Tolerance	ORLT			15	dB	
Relative Intensity Noise	RIN <sub>15</sub> OMA			-113	dB/Hz	
Optical Transmitter Reflectance				-6	dB	
Transmitter and Dispersion Penalty	TDP			2.8	dB	
Output Eye Mask {X1,X2,Y1,Y2,Y3}	Compliant with IEEE 802.3ah {0.22,0.375,0.20,0.20,0.30}					Note (5)

Note (1). Launched power (avg.) is power coupled into a single mode fiber with master connector.

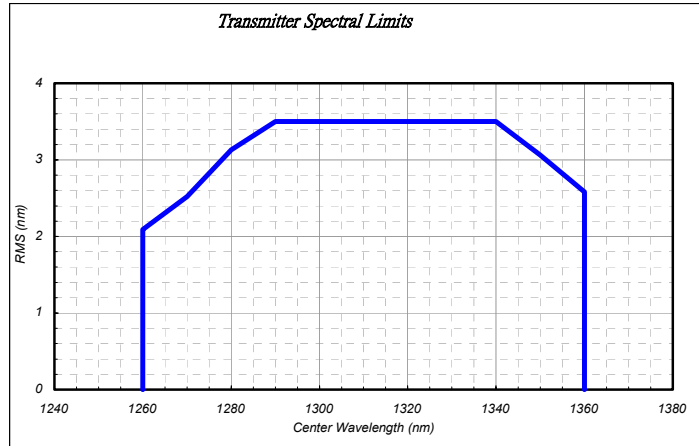
B.O.L=Before of Life; E.O.L= End of Life

Note (2). These are unfiltered 20-80% values.

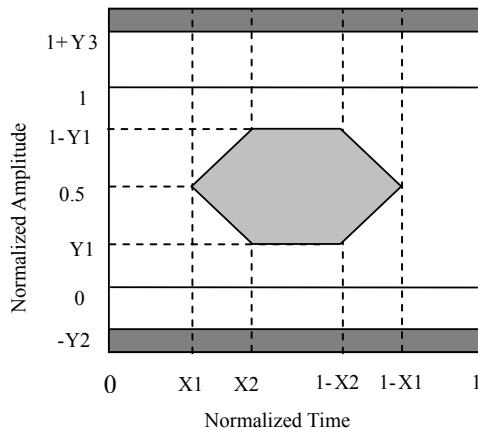
Note (3). Measure at 2<sup>7</sup>-1 NRZ PRBS pattern

Note (4). Transmitter spectral limits

Center Wavelength	RMS spectral width(max) 1000Base-PX10-U
nm	nm
1260	2.09
1270	2.52
1280	3.13
1290	3.50
1295	
1297	
1329	
1331	
1340	
1350	3.06
1360	2.58



Note (5). Transmitter eye mask definition



#### 4. Specification of Receiver

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Input Optical Wavelength	$\lambda_{IN}$	1480	1490	1500	nm	PIN-PD
Receiver Sensitivity	$P_{IN}$			-26	dBm	Note (1)
Input Saturation Power (Overload)	$P_{SAT}$	-3			dBm	
Signal Detect -Assert Power	$P_A$	-		-26	dBm	
Signal Detect -Deassert Power	$P_D$	-44			dBm	Note (2)
Signal Detect Hysteresis	$P_A-P_D$	0.5	2	6	dB	
Data Output Rise/Fall time	$t_r/t_f$			260	ps	Note (3)
Receiver Reflectance	1480 to 1500nm			-12	dB	Note (4)
Optical Isolation from External Source	1260 to 1360nm			-43	dB	
	1550 to 1560nm			-33	dB	
	1640 to 1665nm			-33	dB	

Note (1). Measured with Light source +1dBm, 1490nm, ER=9dB; BER =<math>10^{-12}</math>@PRBS=2<sup>7</sup>-1 NRZ

This assurance should be met with asynchronous data flowing out of the optical transmitter of the system under test. The output data pattern from the transmitter of the system under test is a repetition of alternate 0/1 pattern as defined for this measurement.

Note (2). When SD deasserted, the data output is Low-level (fixed)

Note (3). These are 20%~80% values.

Note (4). Measured at wavelength of 1490nm.

## 5. Electrical Interface Characteristics

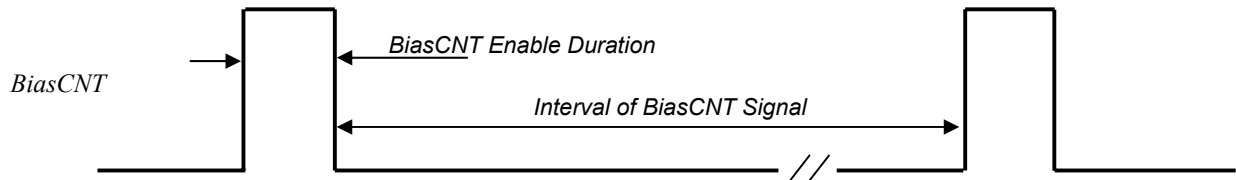
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
<b>Transmitter</b>						
Total Supply Current	I <sub>CC</sub>			A	mA	Note (1)
Differential line input Impedance	R <sub>IN</sub>	80	100	120	Ohm	
Differential Data Input Swing	V <sub>DT</sub>	200		1600	mV <sub>p-p</sub>	
Data Input Voltage- High	V <sub>IH</sub> -V <sub>CC</sub>	-1.165		-0.880	V	LVPECL
Data Input Voltage- Low	V <sub>IL</sub> -V <sub>CC</sub>	-1.810		-1.475	V	
BiasCNT Input Voltage- High	V <sub>BCH</sub>	2		V <sub>CC</sub>	V	LVTTTL
BiasCNT Input Voltage- Low	V <sub>BCL</sub>	0		0.8	V	
<b>Receiver</b>						
Total Supply Current	I <sub>CC</sub>			B	mA	Note (1)
Differential Data Output Swing	V <sub>DR</sub>	400		1600	mV <sub>p-p</sub>	Note (2)
Signal Detect Output Voltage-High	V <sub>LOSH</sub>	2		V <sub>CC</sub> +0.3	V	LVTTTL
Signal Detect Output Voltage-Low	V <sub>LOSL</sub>	0		0.8	V	

Note (1). A (TX)+ B (RX) = 300mA (Not include termination circuit)

Note (2). Internally AC coupled, but requires a 100Ohm differential termination at or internal to Serializer/Deserializer.

### 6. Transmitter Burst Mode Timing Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
BiasCNT Enable Duration		1			us	
Interval of BiasCNT Signal		0.112		1000000	us	



VccT	BiasCNT	Data Input	Optical Output
VccT < 3.1V	X	X	OFF
VccT > 3.1V	Low	X	OFF
	High	Floating	Other
		Present	Laser bias and modulation signal output

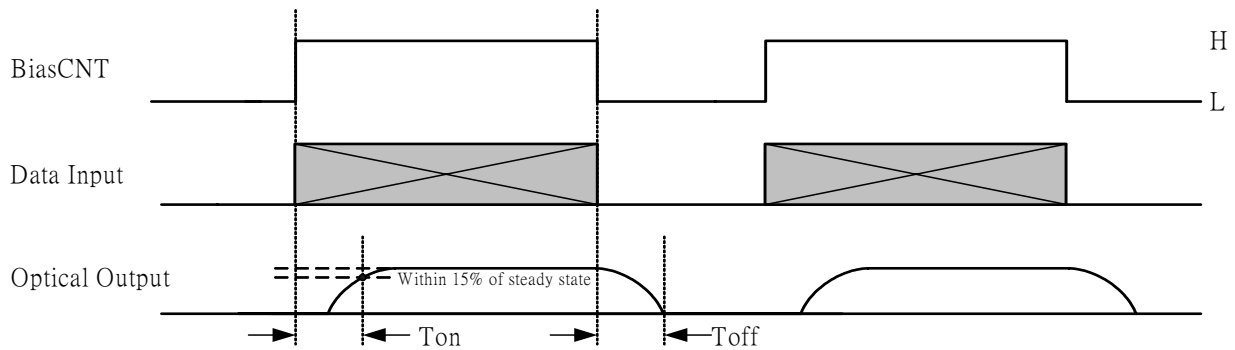
X = Don't care

Other = Less than +7.5dBm (peak)

High = Logic high level, Low = logic low level

Floating = No Data Input, Present = Data Input,

OFF = Optical Power is less than -45dBm



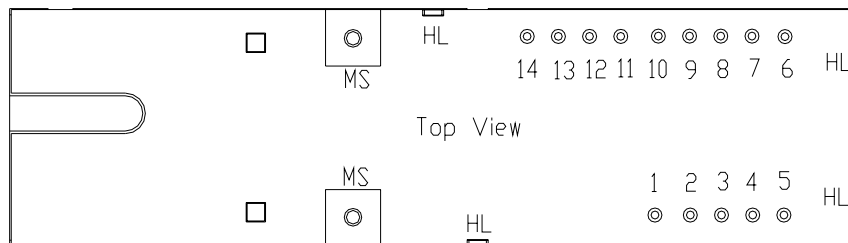
### 7. Digital Diagnostic Monitor Accuracy

Parameter	Accuracy	Unit	Calibration	Note
Transceiver Internal Temperature	± 3°C	°C	Internal	Tc=-20~+85°C
Power Supply Internal Voltage	± 3%	V	Internal	Vcc=3.3V±5%
TX Bias Current	± 10%	mA	Internal	Specified by nominal bias value
TX Optical Power	± 3dB	dBm	Internal	Not support in burst ONU
RX Optical Power	± 3dB	dBm	Internal	-26 to -3dBm

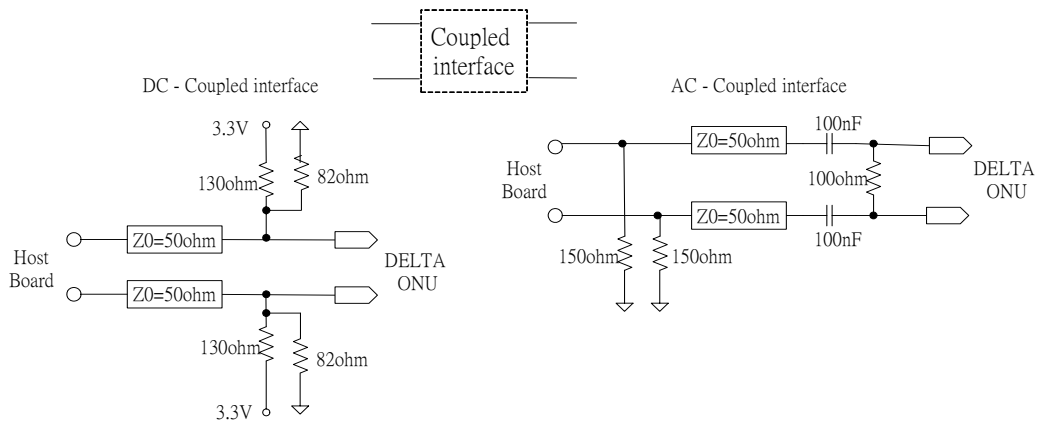
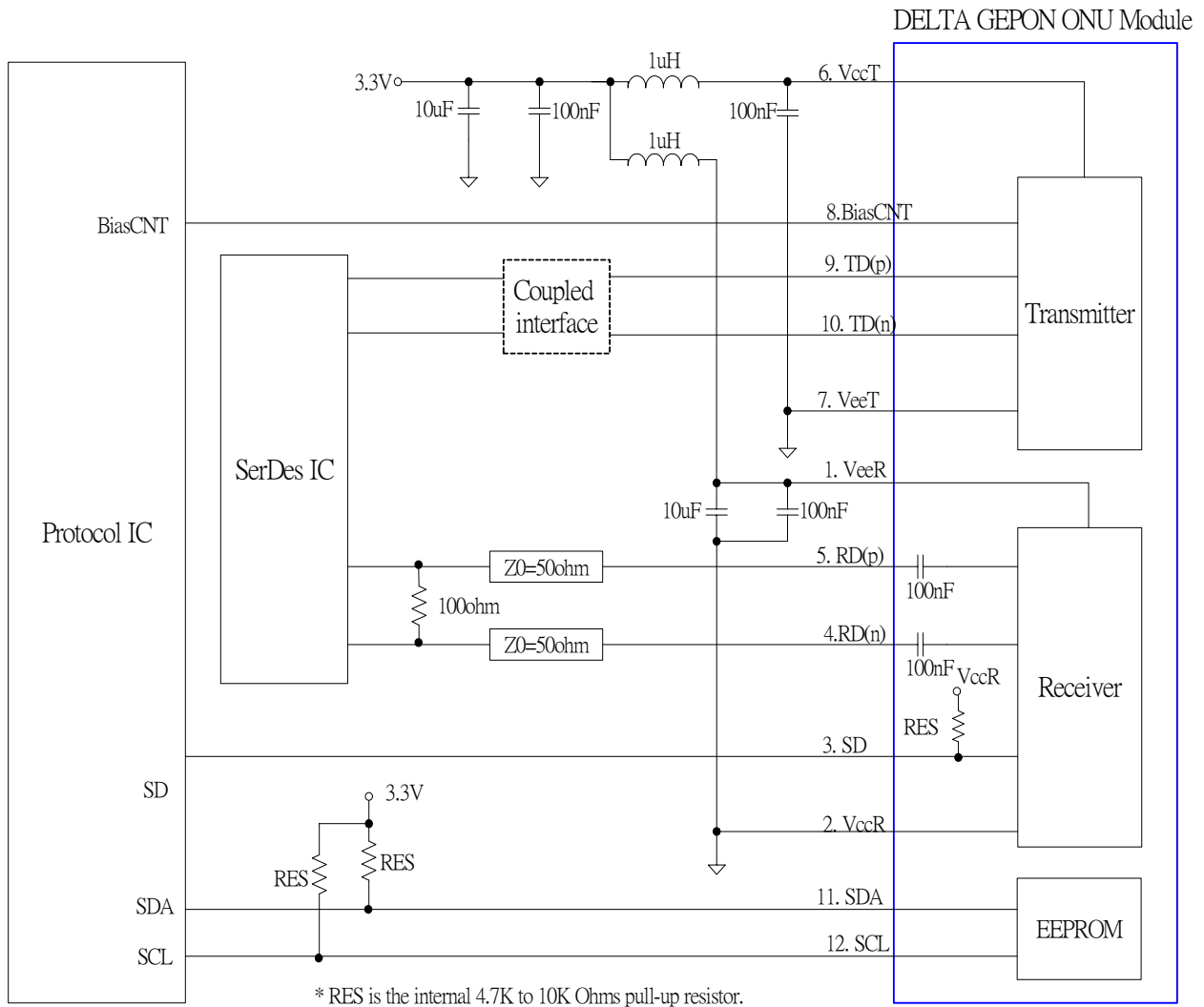
Note. Temperature and Voltage is measured internal to the transceiver.

### 8. Pin Description

Tx/Rx	Pin No.	I/O	Pin Name	Description
Rx	1		VeeR	Receiver Ground
	2		VccR	+3.3V Receiver Power Supply
	3	O	SD	Normal Optical Input indicated by logic "High", and No Optical Input indicated by logic "Low".
	4	O	RD(n)	Inverted Receiver Data Output (AC-Coupled)
	5	O	RD(p)	Non-Inverted Receiver Data Output (AC-Coupled)
Tx	6		VccT	+3.3V Transmitter Power Supply
	7		VeeT	Transmitter Ground
	8	I	BiasCNT	Positive pulse which control the ONU burst mode operation
	9	I	TD(p)	Non-Inverted Transmitter Data Input
	10	I	TD(n)	Inverted Transmitter Data Input
	11		VeeT	Transmitter Ground
	12		NC	Not Connect
	13	I/O	SDA	I2C Serial Data Input/Output (LVTTTL) (Mod-Def 2)
	14	I	SCL	I2C Serial Clock Input (LVTTTL) (Mod-Def 1)
			MS	Mounting Studs/Connect this pin to Chassis ground
			HL	EMI Shielding Leads/ connect this pin to Chassis/ Signal ground

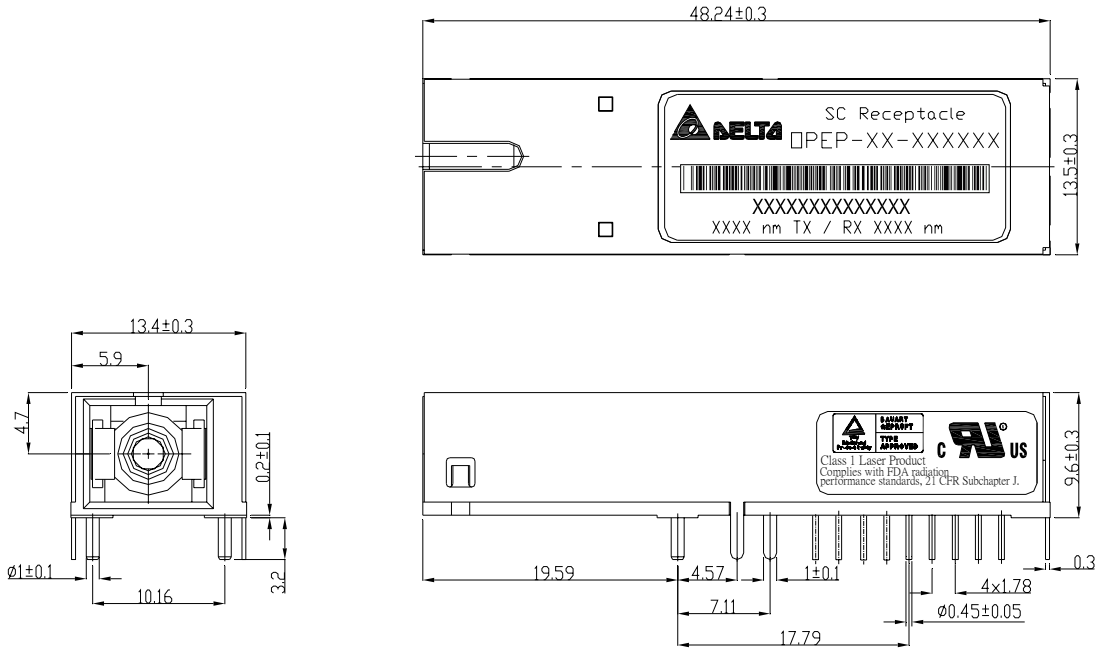


### 9. Recommended Interface Circuit

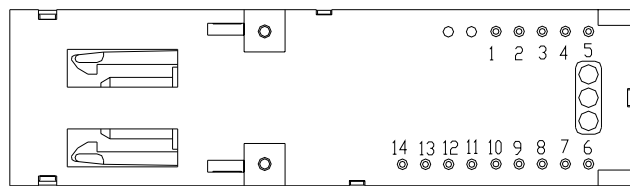


### 10. Outline Dimensions

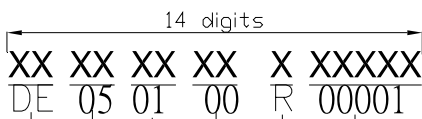
Parameter	Unit	Description	Note
Mechanical Dimensions	mm	48.3x13.5x9.6	
Connector Type	-	SC/UPC connector	IEC-61754-4



NOTE:  
 1.UNITS IN mm  
 2.DIMENSIONAL TOLERANCES ±0.2



### S/N

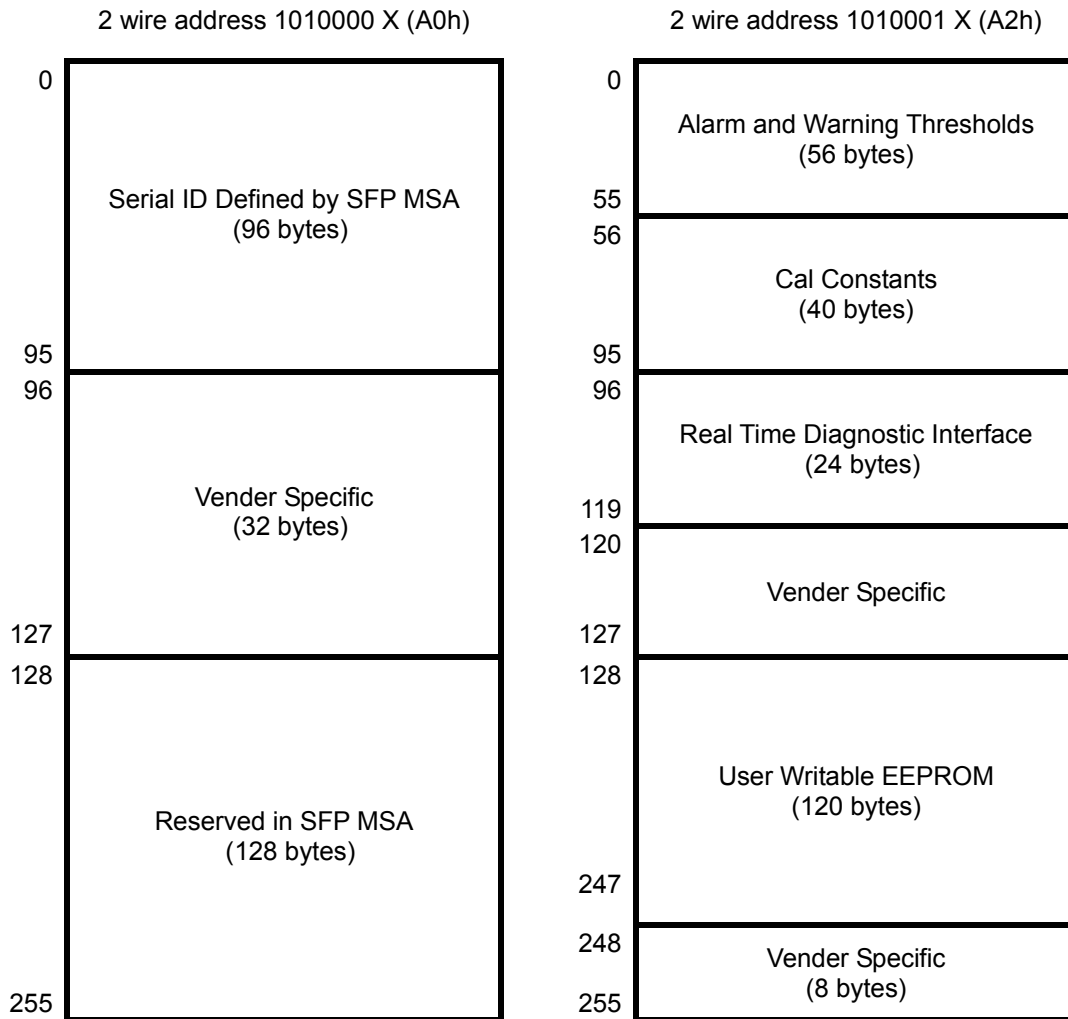


S/N : (00001~99999)  
 Rework : Rework=R or No-rework=0  
 Vender NOTE : Free or 00  
 Week (52Weeks/Year) : 1月2日=01  
 Year : 2005=05  
 Vender CODE : DELTA=DE



### 11. Enhanced Digital Diagnostic Interface

The memory map in the following describes an extension to the memory map defined in SFF-8472. The enhanced interface uses the two wire serial bus address 1010001X(A2h) to provide diagnostic information about the module's present operating conditions.



**EEPROM Serial ID Memory Contents (2-Wire Address A0h)**

Address	Name of Field	Hex	Description
<b>Base ID Fields</b>			
00	Identifier	80	Vendor specific
01	Ext. Identifier	04	Serial ID module supported
02	Connector	01	SC connector
03-10	Transceiver Codes	00 00 00 80 00 00 00 00	BASE-PX
11	Encoding	01	Compatible with 8B/10B encoding code
12	BR, Nominal	0D	Nominal 1250Mbps
13	Reserved	00	
14	Length (9um)-km	0A	10km @9/125um fiber
15	Length (9um)-100m	64	10000m @9/125um fiber
16-18	Length for MMF	00	Undefined in MMF
19	Reserved	00	
20-35	Vendor Name	44 45 4C 54 41 20	"DELTA" (ASCII character)
36	Channel Spacing	00	Undefined
37-39	Vendor OUI	00	Undefined
40-55	Vendor P/N	4F 50 45 50 2D 33 33 2D 41 34 51 31 52 49 20 20	"OPEP-33-A4Q1RI" (ASCII character)
56-59	Vendor P/N Rev.	41 20 20 20	"A" (ASCII character)
60-61	Laser Wavelength	05 1E	1310nm in Hex byte
62	DWDM Wavelength Fraction	00	Undefined
63	CC_BASE	XX	Check sum of bytes 0-62
<b>Extended ID Fields</b>			
64-65	Options	00 00	
66	BR, Max.	00	
67	BR, Min.	00	
68-83	Vendor SN	XX	"DEYYWWVVRSSSSS" in ASCII character
84-91	Date Code	XX	"YYMMDD" in ASCII character
92	Diagnostic Monitoring Type	68	Implemented with internal calibration and received power measurement type by Avg. power
93	Enhanced options	80	Alarm/Warning flags monitor are implemented
94	SFF-8472 compliant	01	SFF-8472 compliant with revision 9.3
95	CC_EXT	XX	Check sum of bytes 64-94
<b>Vendor Specific ID Fields</b>			
96-127	Vendor Specific	00	Vendor specific EEPROM
128-256	Reserved	00	Reserved for future use

**Digital Diagnostic Monitoring Interface (2-Wire Address A2h)**
**Alarm and Warning Thresholds (2 Wire Address A2h)**

Address	# Bytes	Name of Field	HEX	Real Value	Unit
00-01	2	Temp High Alarm	64 00	100°C	°C
02-03	2	Temp Low Alarm	DD 00	-35°C	°C
04-05	2	Temp High Warning	5A 00	90°C	°C
06-07	2	Temp Low Warning	E7 00	-25°C	°C
08-09	2	Voltage High Alarm	94 70	3.8	V
10-11	2	Voltage Low Alarm	6D 60	2.8	V
12-13	2	Voltage High Warning	87 8C	3.47	V
14-15	2	Voltage Low Warning	7A 44	3.13	V
16-17	2	Bias High Alarm	4E 20	40	mA
18-19	2	Bias Low Alarm	01 F4	1	mA
20-21	2	Bias High Warning	3A 98	30	mA
22-23	2	Bias Low Warning	01 F4	1	mA
24-25	2	TX Power High Alarm	No implemented for Burst Mode.		
26-27	2	TX Power Low Alarm			
28-29	2	TX Power High Warning			
30-31	2	TX Power Low Warning			
32-33	2	RX Power High Alarm			
34-35	2	RX Power Low Alarm	00 0D	-29	dBm
36-37	2	RX Power High Warning	13 94	-3	dBm
38-39	2	RX Power Low Warning	00 19	-26	dBm
40-55	16	Reserved			

**Calibration Constants (2 Wire Address A2h)**

Address	# Bytes	Name of Field	HEX	Description
56-59	4	Rx_PWR (4)	00 00 00 00	Set to zero for "internally calibrated" devices.
60-63	4	Rx_PWR (3)	00 00 00 00	Set to zero for "internally calibrated" devices.
64-67	4	Rx_PWR (2)	00 00 00 00	Set to zero for "internally calibrated" devices.
68-71	4	Rx_PWR (1)	3F 80 00 00	Set to 1 for "internally calibrated" devices.
72-75	4	Rx_PWR (0)	00 00 00 00	Set to zero for "internally calibrated" devices.
76-77	2	Tx_I (Slope)	01 00	Set to 1 for "internally calibrated" devices.
78-79	2	Tx_I (Offset)	00 00	Set to zero for "internally calibrated" devices.
80-81	2	Tx_PWR (Slope)	01 00	Set to 1 for "internally calibrated" devices.
82-83	2	Tx_PWR (Offset)	00 00	Set to zero for "internally calibrated" devices.
84-85	2	T (Slope)	01 00	Set to 1 for "internally calibrated" devices.
86-87	2	T (Offset)	00 00	Set to zero for "internally calibrated" devices.
88-89	2	V (Slope)	01 00	Set to 1 for "internally calibrated" devices.
90-91	2	V (Offset)	00 00	Set to zero for "internally calibrated" devices.
92-94	3	Reserved	00 00 00	Reserved
95	1	Checksum	XX	Checksum of bytes 0 – 94.

**A/D Value (2 Wire Address A2h)**

Address	# Bytes	Name of Field	Description
96-97	2	Temperature (MSB, LSB)	Internally measured module temperature
98-99	2	Supply Voltage (MSB, LSB)	Internally measured supply voltage in module
100-101	2	Tx Bias Current (MSB, LSB)	Internally measured Tx Bias current
102-103	2	Tx Optical Power (MSB, LSB)	No implemented for Burst Mode.
104-105	2	Rx Received Power (MSB, LSB)	Measured Rx input power
106-109	4	Reserved	

Notes:

Temperature (Signed twos complement value)

A2h Byte 96 (Temperature MSB)								A2h Byte 97 (Temperature LSB)							
S	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>	2 <sup>-1</sup>	2 <sup>-2</sup>	2 <sup>-3</sup>	2 <sup>-4</sup>	2 <sup>-5</sup>	2 <sup>-6</sup>	2 <sup>-7</sup>	2 <sup>-8</sup>

Supply Voltage, Tx Bias Current, Tx Optical Power, Rx Received Power (Unsigned values)

A2h Byte 98 (V <sub>cc</sub> MSB)								A2h Byte 99 (V <sub>cc</sub> LSB)							
A2h Byte 100 (TX Bias MSB)								A2h Byte 101 (TX Bias LSB)							
A2h Byte 102 (TX Power MSB)								A2h Byte 103 (TX Power LSB)							
A2h Byte 104 (RX Power MSB)								A2h Byte 105 (RX Power LSB)							
2 <sup>15</sup>	2 <sup>14</sup>	2 <sup>13</sup>	2 <sup>12</sup>	2 <sup>11</sup>	2 <sup>10</sup>	2 <sup>9</sup>	2 <sup>8</sup>	2 <sup>7</sup>	2 <sup>6</sup>	2 <sup>5</sup>	2 <sup>4</sup>	2 <sup>3</sup>	2 <sup>2</sup>	2 <sup>1</sup>	2 <sup>0</sup>

The digital value conversions are updated every 13ms (nominal) or 20ms (max) in rotation. After getting digital value, each measurement could be obtained by multiplying digital value by corresponding LSB value:

$$\text{Temperature} = \text{Temp (Digital Value)} \times \text{LSB}_{\text{Temp}} = \text{Temp (Digital Value)} \times \frac{1}{256}; \text{ when Temperature} < 128$$

$$\text{Temperature} = \text{Temp (Digital Value)} \times \text{LSB}_{\text{Temp}} = [\text{Temp (Digital Value)} \times \frac{1}{256}] - 256; \text{ when Temperature} \geq 128$$

$$V_{cc} = V_{cc}(\text{Digital Value}) \times \text{LSB}_{V_{cc}} = V_{cc}(\text{Digital Value}) \times 100\mu\text{V}$$

$$\text{TX Bias Current} = \text{TX Bias Current (Digital Value)} \times \text{LSB}_{\text{TX,Bias}} = \text{TX Bias Current (Digital Value)} \times 2\mu\text{A}$$

$$\text{TX Power} = \text{TX Power (Digital Value)} \times \text{LSB}_{\text{TXPower}} = \text{TX Power (Digital Value)} \times 0.1\mu\text{W}$$

$$\text{RX Power} = \text{RX Power (Digital Value)} \times \text{LSB}_{\text{RXPower}} = \text{RX Power (Digital Value)} \times 0.1\mu\text{W}$$

**Status Bits and Alarm/Warning Flag Bits (2 Wire Address A2h)**

Address	Bit	Name	Description
110	7	TX Disable State	No implemented.
110	6	Soft TX Disable	No implemented.
110	5	Reserved	
110	4	RX Rate Select State	No implemented.
110	3	Soft RX Rate Select	No implemented.
110	2	TX Fault State	No implemented.
110	1	Signal Detect State	No implemented.
110	0	Data_Ready_Bar	No implemented.
111	All	Reserved	
112	7	Temp High Alarm	Set when internal temperature exceeds high alarm level.
112	6	Temp Low Alarm	Set when internal temperature is below low alarm level.
112	5	Vcc High Alarm	Set when internal supply voltage exceeds high alarm level.
112	4	Vcc Low Alarm	Set when internal supply voltage is below low alarm level.
112	3	TX Bias High Alarm	Set when TX Bias current exceeds high alarm level.
112	2	TX Bias Low Alarm	Set when TX Bias current is below low alarm level.
112	1	TX Power High Alarm	No implemented for Burst Mode.
112	0	TX Power Low Alarm	No implemented for Burst Mode.
113	7	RX Power High Alarm	Set when Received Power exceeds high alarm level.
113	6	RX Power Low Alarm	Set when Received Power is below low alarm level.
113	5-0	Reserved Alarm	
114-115	All	Reserved	
116	7	Temp High Warning	Set when internal temperature exceeds high warning level.
116	6	Temp Low Warning	Set when internal temperature is below low warning level.
116	5	Vcc High Warning	Set when internal supply voltage exceeds high warning level.
116	4	Vcc Low Warning	Set when internal supply voltage is below low warning level.
116	3	TX Bias High Warning	Set when TX Bias current exceeds high warning level.
116	2	TX Bias Low Warning	Set when TX Bias current is below low warning level.
116	1	TX Power High Warning	No implemented for Burst Mode.
116	0	TX Power Low Warning	No implemented for Burst Mode.
117	7	RX Power High Warning	Set when Received Power exceeds high warning level.
117	6	RX Power Low Warning	Set when Received Power is below low warning level.
117	5-0	Reserved Warning	
118-119	All	Reserved	

**Vendor Specific and User Accessible EEPROM (2 Wire Address A2h)**

Address	# Bytes	Name	Description
120-122	3	Reserved	
123	1	Password Byte 3	High order byte of 32 bit password
124	1	Password Byte 2	Second highest order byte of 32 bit password
125	1	Password Byte 1	Second lowest order byte of 32 bit password
126	1	Password Byte 0	Low order byte of 32 bit password
127	1	User EEPROM Select	"1" selects user writable EEPROM at locations 128-247
128-247	120	User EEPROM	User writable EEPROM
248-255	8	Vendor Specific	Vendor specific control functions

## 12. Regulatory Compliance

Feature	Test Method	Reference	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	Human Body Model (HBM)	MIL-STD-883E Method 3015.7 EIA-JESD22-A114	(1) Satisfied with electrical characteristics of product spec.  (2) No physical damage
	Machine Model (MM)	EIA-JESD22-A115	
Electrostatic Discharge (ESD) to the Simplex Receptacle	Contact Discharge	IEC/EN 61000-4-2	
	Air Discharge	IEC/EN 61000-4-2	
Radio Frequency Electromagnetic Field Immunity		IEC/EN 61000-4-3	
Electromagnetic Interference (EMI)		FCC Part 15 Class B EN 55022 Class B (CISPR 22A)	
Laser Eye Safety	FDA/CDRH	FDA 21CFR 1040.10, 1040.11	CDRH File # 0420993
	TUV	IEC/EN 60825-1 IEC/EN 60825-2	TUV Certificate # R50032471
Component Recognition	TUV	IEC/EN 60950	
	UL/CSA	UL 60950	UL File # E239394

## Appendix A. Document Revision

Version No.	Date	Description
S0	2006-11-06	Preliminary Datasheet
S1	2007-08-08	Change the PIN outline, DDM accuracy and Differential Data Input Swing
S2	2007-10-10	Update the DDM description and Receiver Saturation
S3	2007-12-20	Update the DDM contents